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ABSTRACT

Cross-national classroom environment research investigating differences in mathematics classroom environment according to country (Australia, Canada, and the United Kingdom), grade level (grades 8, 10, and 12), and student gender was conducted using a sample of 3,602 students from 29 schools. Students responded to a questionnaire developed from seven scales of the What Is Happening in this Class questionnaire (B. Fraser, 1998) and three scales of the Constructivist Learning Environment Survey (P. Taylor, B. Fraser, and D. Fisher, 1997). Validation data showed these 10 scales to have sound structural characteristics. Results for the comparison of classroom environment in Australia, Canada, and the United Kingdom were mixed. Tests of significance revealed that the environment in mathematics classes in the three countries differed significantly on some scales with Canadian schools having higher levels of Investigation and Personal Relevance than their Australian and British counterparts. In general, grade 8 students held more positive perceptions of their mathematics classrooms than did grade 10 and grade 12 students. Female students generally perceived their mathematics classroom more positively than did male students. (Contains 3 tables, 2 figures, and 20 references.) (Author/SLD)

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CROSS-NATIONAL VALIDATION AND USE OF CLASSROOM ENVIRONMENT SCALES

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Abstract

Cross-national classroom environment research investigating differences in mathematics classroom environment according to country (viz. Australia, Canada and the United Kingdom), grade level (Grades 8, 10 and 12) and student gender was conducted using a sample of 3,602 students from 29 schools. Students responded to a questionnaire developed from 7 scales of the What is Happening in this Class questionnaire and 3 scales of the Constructivist Learning Environment Survey. Validation data showed these 10 scales to have sound structural characteristics. Results for the comparison of classroom environment in Australia, Canada and the United Kingdom were mixed. Tests of significance revealed that the environment in mathematics classes in these three countries differed significantly on some scales with Canadian schools having higher levels of Investigation and Personal Relevance that their Australian and British counterparts. In general, Grade 8 students held more positive perceptions of their mathematics classrooms than did Grade 10 and Grade 12 students. Female students generally perceived their mathematics classroom more positively than did male students.

During the past 20 years, considerable research effort has been placed on the development and validation of instruments to assess the psychosocial environment dimensions of classrooms. Most of this research has been conducted in the United States and Australia. Two relatively recent additions to the suite of instruments now available are the What is Happening in this Class questionnaire (WIHIC: Fraser, 1998b) and the Constructivist Learning Environment Survey (CLES: Taylor, Fraser & Fisher, 1997). The present research was aimed at validating scales from the WIHIC and CLES in Australian, British and Canadian high schools. Additionally, the study illustrated the use of these scales by comparing environment in these countries and in different grade levels. A third comparison investigated differences between male and female students in coeducational classrooms. Before the design and results of the present study are presented, a brief review of the learning environment field is provided.

Background

Classroom Environment

Research conducted over the past 30 years has shown the quality of the classroom environment in schools to be a significant determinant of student learning (Fraser, 1994, 1998a). That is, students learn better when they perceive the classroom environment positively. Numerous research studies have shown that student perceptions of the classroom environment account for appreciable amounts of variance in learning outcomes, often beyond that attributable to background student characteristics. For example, Goh and Fraser (1998) use the Questionnaire on Teacher Interaction (QTI: Wubbels & Levy, 1993) to establish associations between student outcomes and perceived patterns of teacher-student interaction in primary school mathematics classes in Singapore. Other studies have used classroom environment scales as dependent variables in investigating variations in environment across different settings. Studies reviewed by Fraser (1998b) have shown that classroom environment varies according to school type (i.e., coeducational, boys' and girls'), grade level and subject area. Some areas of contemporary classroom environment research include investigating special education classrooms in England (Adams, 2000), studying science classroom environment in Korea (Fisher & Huei-Baik, 1999) and

defining differences between city and country students' perceptions of the learning environment (Waldrip & Fisher, 2000).

The learning environment field has developed rapidly with an array of validated instruments and research in at least twelve domains (e.g. evaluation of educational innovations, comparison of actual and preferred environments, and changes in classroom environment during the transition from primary to secondary school) (see Fraser, 1998b). Typically, empirical studies have employed these instruments or contextually modified derivatives to assess the particular environment under investigation. For example, the Catholic School Classroom Environment Questionnaire was developed specifically to assess the environment in Australian Catholic school classrooms (Dorman, 1999). The present study builds upon and extends this field of research by incorporating in the one study the latest learning environment instrumentation.

The Present Research

Aims

The study had two aims:

- to validate scales from the What is Happening in this Class and Constructivist Learning Environment Survey questionnaires in mathematics classes in Australia, Canada, and the United Kingdom, and
- to examine differences in students' perceptions of mathematics classroom environment according to country, grade level and gender.

Sample

The identifiable sample employed in this study consisted of 3,602 students drawn from 9 Australian, 4 Canadian and 16 British high schools. Students from Grades 8, 10 and 12 participated in the study. Table 1 describes the sample. It should be noted that students were grouped according to grade level. Overall, the sample formed 76 school grade groups, 61 of which were coeducational. This grouping of students was

important because subsequent analyses used the school grade group as the unit of analysis.

Table 1 about here

Assessment of Classroom Environment

An important principle of the present study was to provide a comprehensive, parsimonious assessment of contemporary classroom environment. Significant recent work that attempts to bring parsimony to the field of learning environments by combining the most salient scales from existing questionnaires has produced an instrument called the What is Happening in this Class questionnaire (WIHIC). While the WIHIC is comprehensive, it is not designed to assess constructivist classroom environments. In a constructivist environment, meaningful learning is a cognitive process in which students make sense of the world in relation to the knowledge which they have constructed. The Constructivist Learning Environment Survey (CLES) was developed to assist researchers to assess the constructivist dimensions of classrooms.

In the present study, seven scales from the WIHIC and three scales from the CLES provided a comprehensive assessment of classroom environment. From the original 56-item WIHIC, 42 items from its seven a priori scales were selected. From the CLES, 18 items from three scales were selected. Table 2 shows each of these six-item scales and their common sense descriptions. Each item used a 5-point response format (viz. Almost Never, Seldom, Sometimes, Often, Almost Always). Additionally, Table 2 shows the classification of each scale according to Moos's (1974) three general categories for conceptualising human environments (viz. Relationship, Personal Development, and System Maintenance and System Change).

Table 2 about here

Methods of Analysis

An important consideration in learning environment research is the choice of unit of analysis. In the present study, individual students were nested within school grade groups. Use of the individual as the unit of analysis can provide spurious results because an unjustifiably small estimate of the sampling error is employed in tests of significance. Additionally, students in grade groups are not statistically independent and the results of any subsequent test of significance could be questioned. While validation data have been provided for both the individual and school grade mean as units of analysis, comparisons employed the grade mean in each school as the unit of analysis. Multivariate analysis of variance was used to compare classroom environment in Australian, Canadian and British schools and in Grades 8, 10 and 12. To compare male and female perceptions of environment in Coeducational classes, a repeated measures MANOVA was used. To gauge the effect of the independent variable (e.g. country), Cohen's (1977) effect size – the difference in group means as a fraction of the full sample standard deviation – was used as a convenient index.

Validation of Scales

Classroom Environment

Scale Internal Consistency. Estimates of the internal consistency of the ten classroom environment scales were calculated using Cronbach's Coefficient alpha. Table 3 shows these values using the individual student and school grade mean as units of statistical analysis. As expected, the values of Coefficient alpha based on school grade means were somewhat larger than those obtained with the individual as the unit of analysis (Fraser, 1986). All scales had good internal consistency for both the individual and school grade mean as units of analysis.

Table 3 about here

Discriminant validity. Table 3 also reports data about the discriminant validity of the scales using the mean correlation of a scale with the remaining nine scales as an

index. These data indicate that the scales do overlap but not to the extent that would violate the psychometric structure of the instrument. Additionally, the data compare favourably with discriminant validity data of other well-established classroom environment instruments (see Fraser, 1998b).

Ability to differentiate between classes. As shown in Table 3, one-way ANOVAs for each classroom environment scale with the student as the unit of analysis and school grade group membership as the main effect showed that each scale differentiated significantly between school grade groups ($p<.001$). The eta^2 statistic, which is a ratio of "between" to "total" sums of squares (Cohen & Cohen, 1975), indicates that the proportion of variance explained by class membership ranged from 6% for the Involvement scale to 13% for the Personal Relevance scale.

Results

Differences Between the Environment in Australian, Canadian and British Mathematics Classes

A two-way MANOVA, with the set of 10 classroom environment scales as the dependent variables and country and grade level as the independent variables, was performed. The school type by grade level interaction was not significant ($p<.001$). Because the effect of country was significant (Wilks' $\lambda = 0.36$, $p < .001$), univariate F tests were interpreted. These tests revealed that the environment in mathematics classes in these three countries differed significantly on five scales: Teacher Support [$F(2,67) = 3.08$ ($p<.05$)], Investigation [$F(2,67) = 6.70$ ($p<.01$)], Task Orientation [$F(2,67) = 7.75$ ($p<.001$)], Equity [$F(2,67) = 4.41$ ($p<.05$)], and Personal Relevance [$F(2,67) = 12.40$ ($p<.001$)]. Tukey's post-hoc procedure showed that the significant differences were between British and Australian schools and between British and Canadian schools for Investigation and Personal Relevance. Additionally, Australian and British schools differed significant on the level of Task Orientation. Figure 1 shows scale means scores for each country. Mathematics students in Canadian schools perceived higher levels of Investigation and Personal Relevance that did their Australian and British counterparts. Equity in British schools was significantly higher

than that recorded in Australian schools (see Figure 1). Effect sizes (which were moderate to large) ranged from 0.65 for the comparison of Investigation in Australian and British schools to 1.11 for the comparison of Personal Relevance in Canadian and British schools.

Figure 1 about here

Differences Between the Environments of Grade 8, 10 and 12 Classes

In the MANOVA described above, the effect of grade level was significant (Wilks' $\lambda = 0.33$, $p<.001$). Univariate F tests investigating the effect of grade level on classroom environment were significant for four scales: Investigation [$F(2,67) = 9.09$ ($p<.001$)], Task Orientation [$F(2,67) = 3.81$ ($p<.05$)], Personal Relevance [$F(2,67) = 21.86$ ($p<.001$)], and Shared Control [$F(2,67) = 4.92$ ($p<.01$)]. Tukey's post-hoc procedure showed that, for these four scales, the perceptions of Grade 8 students differed significantly from Grades 10 and 12 students ($p<.05$). The sample data are graphed in Figure 2 and clearly indicate that students in Grades 8 held more positive perceptions of their mathematics classrooms than did Grade 10 and Grade 12 students. In fact, as grade level increases, students' perceptions of Investigation, Task Orientation, Personal Relevance and Shared Control decreases. Effect sizes ranged from 0.51 for the comparison of Personal Relevance in Grades 10 and 12 to 1.44 for the comparison of Personal Relevance in Grades 8 and 12. Overall, effect sizes were moderate to large.

Figure 2 about here

Differences Between Male and Female Students' Perceptions of Coeducational Classroom Environment

To investigate the effect of gender on classroom environment, the sub-sample of coeducational schools was used to compute scale gender means for each school grade level. This approach to data analysis eliminated the possibility of confounding gender

with school type (viz. boys', girls and coeducational). Accordingly, the data set for this analysis consisted of 61 pairs of scale gender means for each school grade group. A two-way repeated measures MANOVA with gender as the within-subjects effect and country and grade level as between-subject effects was performed on the data. There were no significant interaction effects ($p<.05$). The effect of gender was significant (Wilks' λ = 0.40, $p<.001$). Univariate F tests revealed significant differences on seven scales: Student Cohesiveness [$F(1,53)$ = 26.27 ($p<.001$)], Teacher Support [$F(1,53)$ = 14.29 ($p<.001$)], Task Orientation [$F(1,53)$ = 5.44 ($p<.05$)], Cooperation [$F(1,53)$ = 27.56 ($p<.001$)], Equity [$F(1,53)$ = 12.94 ($p<.001$)], Shared Control [$F(1,53)$ = 6.76 ($p<.01$)] and Student Negotiation [$F(1,53)$ = 10.45 ($p<.01$)]. Figure 3 shows the gender mean scores for the coeducational sample. The noteworthy feature of Figure 3 is that, in general, female students perceived their mathematics classroom more positively than did male students. Effect sizes for these significant gender comparisons ranged from 0.50 for Task Orientation to 0.96 for Cooperation with a mean effect size of 0.70. These effect sizes are moderate to large.

Figure 3 about here

Discussion

Over the past decade, several studies have employed cross-national samples to validate instruments. For example, in the development and validation of the Science Laboratory Environment Inventory (SLEI), Fraser, McRobbie, and Giddings (1993) conducted field testing in Australia, the United States, Canada, England, Israel and Nigeria. In the development of the WIHIC, Fraser, Fisher and McRobbie (1996) used a sample of Australian and Taiwanese students. Subsequently, Chianh and Fraser (1998) used the WIHIC successfully in Singapore. The validation data of the present study provide additional support for the wide applicability of the WIHIC and the CLES. No studies have compared mathematics classroom environment in high schools in different western countries. The results of this study show that classroom environment does vary between western countries.

The comparison of Grade 8, 10 and 12 classes showed that, in general, as grade level increases, student perceptions of classroom environment decrease. These results are generally inconsistent with four previous studies on the effect of grade level. Randhawa and Michayluk (1975) reported a consistent pattern of reduced Grade 11 class scores compared to Grade 8 on dimensions of the Learning Environment Inventory (Fraser, Anderson & Walberg, 1982). Shaw and Mackinnon (1973) showed that, as grade level increased from Grade 9 to Grade 12, Formality, Favouritism and Goal Direction decreased while Democracy increased. Welch (1979), reported that, compared to high school students, junior high school students perceived more Disorganisation, Formality, Friction, Cliqueness and Favouritism.

The comparison of male and female perceptions of coeducational mathematics classes revealed that, in general, girls perceive the classroom more positively that boys. This pattern of results is consistent with results of previous studies (Dorman, Fraser, & McRobbie, 1997; Fraser, McRobbie & Giddings, 1993; Lawrenz, 1987; Wong & Fraser, 1995). All of these studies reported that females held more favourable perceptions of their classroom environments than male students. For example, Dorman, Fraser, and McRobbie's research which involved a sample of coeducational classes revealed that girls perceived significantly higher levels of Interactions, Cooperation, Task Orientation and Teacher Control than did boys.

Conclusion

The study reported in this paper extends prior classroom environment research in that it provides cross-national validation of seven scales of the What is Happening in this Class questionnaire and three scales of the Constructivist Learning Environment Survey. Given that validation data showed these 10 scales to have sound structural characteristics, teachers and researchers in western countries should employ these instruments with a high degree of confidence. Comparison of classroom environment in Australia, Canada and the United Kingdom, in Grade 8, 10 and 12 classes together with gender comparisons in coeducational grade groups illustrated the utility of these instruments in a variety of school settings.

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TABLE 1
DESCRIPTION OF IDENTIFIABLE SAMPLE BY COUNTRY, GENDER AND GRADE
(N = 3,602 students)

Year Level	Sample Size							
	Australia		Canada		United Kingdom		Total	
	Male	Female	Male	Female	Male	Female	Male	Female
Grade 8	191	172	266	286	338	318	795	776
Grade 10	172	230	224	175	355	360	751	765
Grade 12	134	156	-	-	150	75	284	231
Total	497	558	490	461	843	753	1830	1772

TABLE 2
DESCRIPTIVE INFORMATION FOR 10 CLASSROOM ENVIRONMENT SCALES

Scale Name	Scale Description	Sample Item	Moos's Schema
Student Cohesiveness	The extent to which students know, help and are supportive of one another.	I know other students in this class. (+)	R
Teacher Support	The extent to which the teacher helps, befriends, trusts and is interested in students.	The teacher takes a personal interest in me. (+)	R
Involvement	The extent to which students have attentive interest, participate in discussions, do additional work and enjoy the class.-	I explain my ideas to other students. (+)	R
Investigation	The extent to which skills and processes of inquiry and their use in problem solving and investigation are emphasised.	I carry out investigations to test my ideas. (+)	P
Task Orientation	The extent to which it is important to complete activities planned and to stay on the subject matter.	I pay attention in this class. (+)	P
Cooperation	The extent to which students cooperate rather than compete with one another on learning tasks.	I work with other students in this class. (+)	P
Equity	The extent to which students are treated equally by the teacher.	I am treated the same as other students in this class (+)	S
Personal Relevance	The extent to which school mathematics connects with students' out-of-school experiences.	I learn how mathematics can be part of my out-of school life. (+)	R
Shared Control	The extent to which students are invited to share with the teacher control of the learning environment.	I help the teacher to decide which activities are best for me. (+)	P
Student Negotiation	The extent to which opportunities exist for students to explain and justify to other students their newly developing ideas.	I talk to other students about how to solve problems. (+)	S

Note. R: Relationship P: Personal Development S: System Maintenance and System Change

TABLE 3
VALIDATION DATA AND SCALE STATISTICS FOR CLASSROOM ENVIRONMENT, ACADEMIC EFFICACY AND ACADEMIC SELF-HANDICAPPING SCALES FOR TWO UNITS OF ANALYSIS
(N = 3,602 students in 76 school grade groups)

	Alpha Reliability		Mean Correlation		ANOVA Results		Scale Statistics[a]	
Scale	Student	School Year Group Mean	Student	School Year Group Mean	F (75, 3527)	Eta^2	Mean	Standard Deviation
Student Cohesiveness	.83	.93	.32	.34	3.9*	.09	25.56	1.48
Teacher Support	.84	.93	.42	.38	5.3*	.12	19.68	1.93
Involvement	.79	.81	.45	.41	2.3*	.06	19.41	1.17
Investigation	.85	.90	.40	.27	3.1*	.08	16.68	1.39
Task Orientation	.82	.83	.35	.28	2.9*	.07	24.23	1.20
Cooperation	.76	.86	.42	.46	3.4*	.08	21.62	1.57
Equity	.84	.93	.38	.35	3.8*	.09	23.57	1.52
Personal Relevance	.76	.89	.30	.21	5.4*	.13	17.72	1.77
Shared Control	.88	.93	.32	.28	3.0*	.07	13.42	1.51
Student Negotiation	.80	.85	.41	.45	2.9*	.07	19.57	1.43
Academic Efficacy	.86	.92	-	-	3.2*	.08	36.57	3.14
Self-handicapping	.85	.90	-	-	2.9*	.07	13.42	2.95

* $p < .001$
[a] Scale statistics are based on school grade group means.

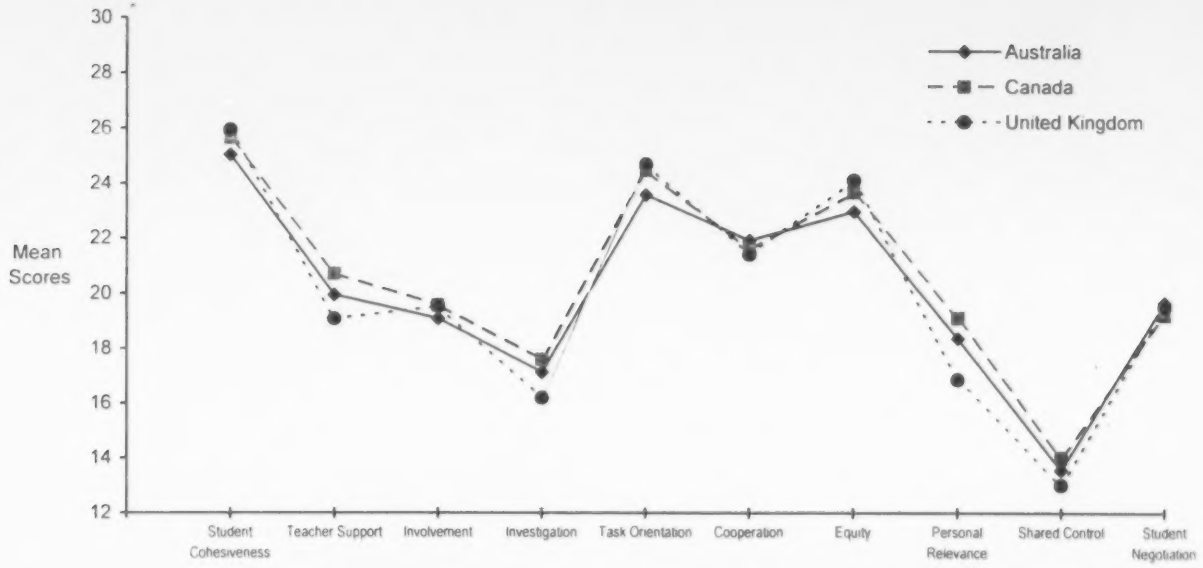

Figure 1 Mean scores for three countries for 10 classroom environment scales (N = 76 school grade groups)

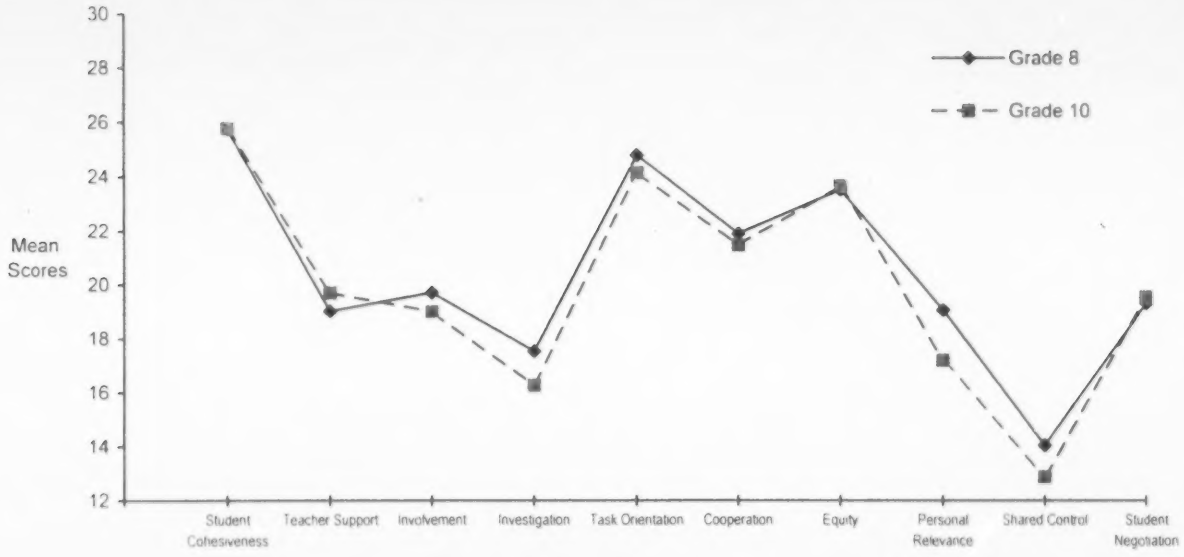

Figure 2 Mean scores for three year levels for 10 classroom environment scales (N = 76 school grade groups)

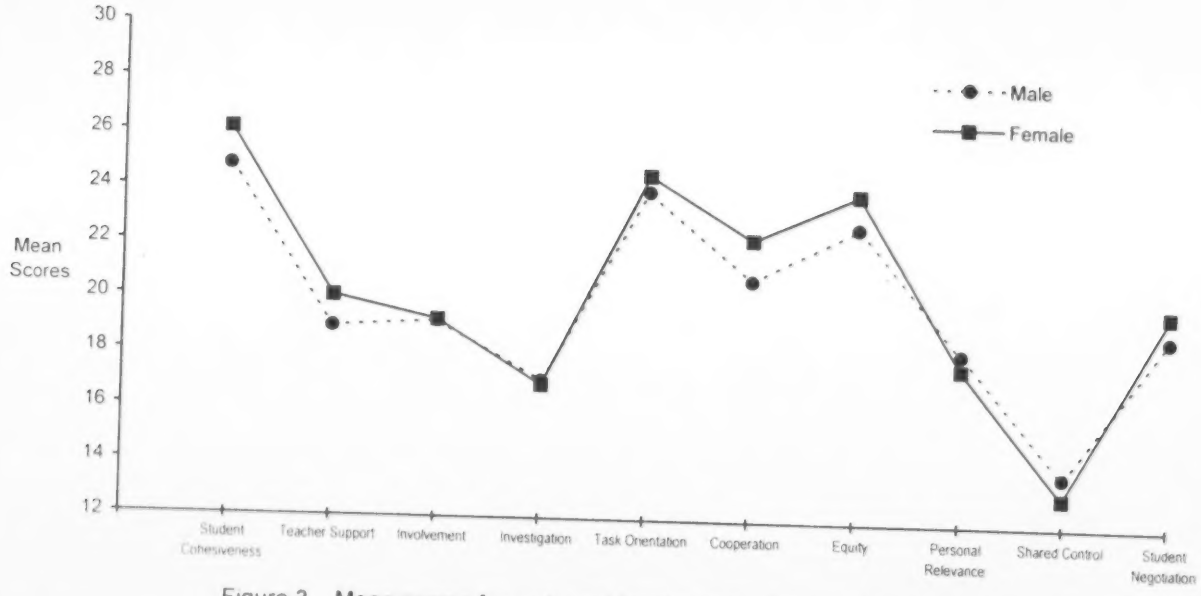

Figure 3 Mean scores for male and female students in coeducational classes for 10 classroom environment scales (N = 61 school grade groups)